

Tracing Volcanic SO₂ plumes using OMI and MLS observations

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Abstract

We tracked the movement of volcanic SO₂ plumes from several large eruptions in the last decades using both Aura OMI and Aura MLS retrievals. Volcanic SO₂ plumes follow different transport pathways depending on the locations and altitude of eruptions. For example Kasatochi (52N, 175 W) plumes (erupted on 08/08/2008) circled around Alaska and nearby Polar region, while plumes from Soufrière Hills (16.7N, 62.2W) eruptions (05/20/2006) traveled with easterly wind, circulated around 10N belt and reached regions as far as Asian Pacific within two weeks. Independent OMI and MLS SO₂ retrievals record the movements of those plumes consistently while from very different perspective, i.e., OMI retrievals show the horizontal extend of volcanic plumes with its broad swath, while MLS provides snap shots of plume's vertical structure. Those two datasets complement each other and provide useful information for tracking strato-volcano plumes and estimating their impacts.

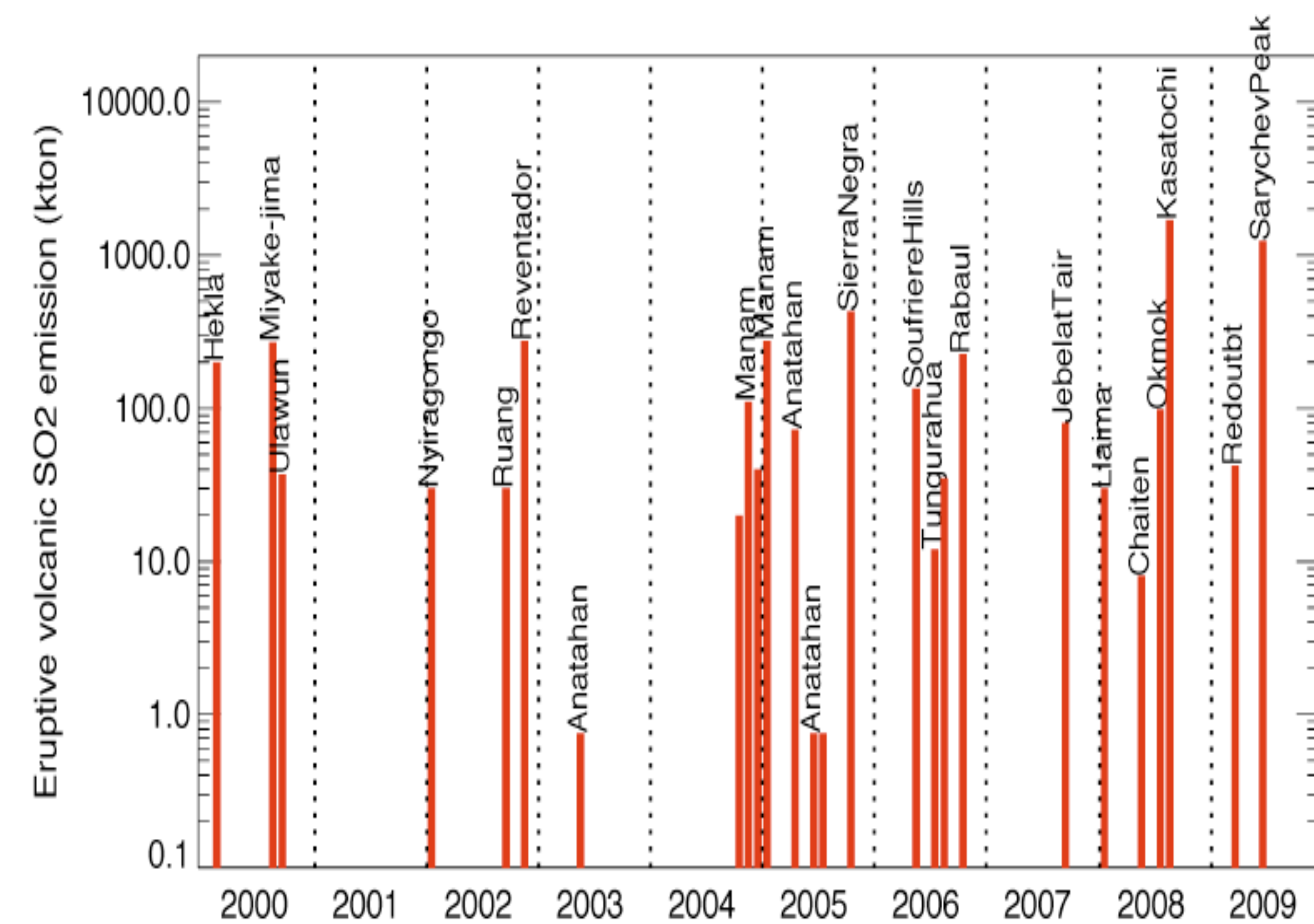


Figure 1. SO₂ emission from eruptive volcanoes from 2000 to 2009 with injection height above 10 km.

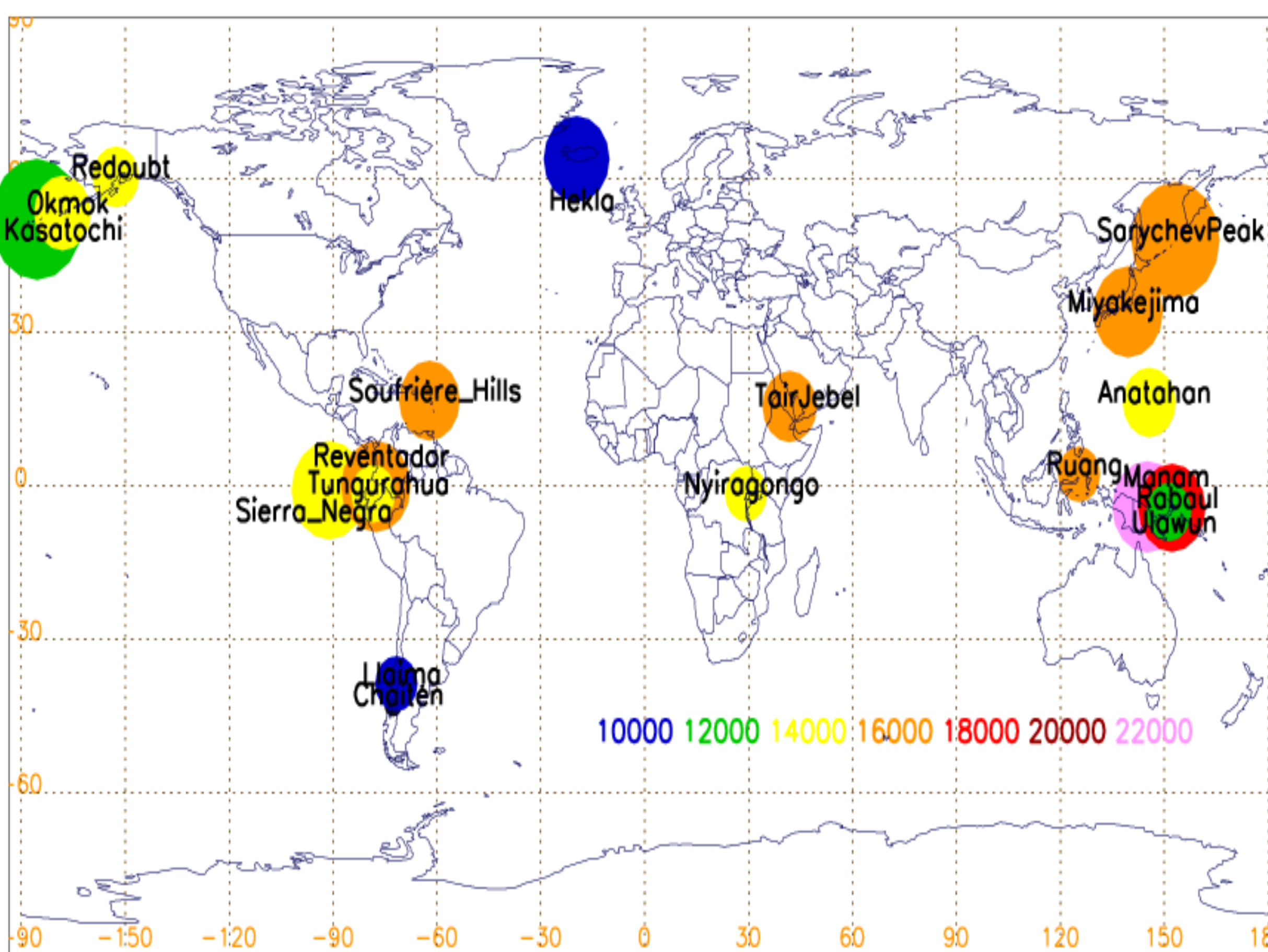


Figure 2. Location, plume height, and SO₂ emission magnitude of volcano eruptions shown in Figure 1. Size of the circles is proportional to the logarithm of emission magnitude, color indicates the height of those plumes in meters.

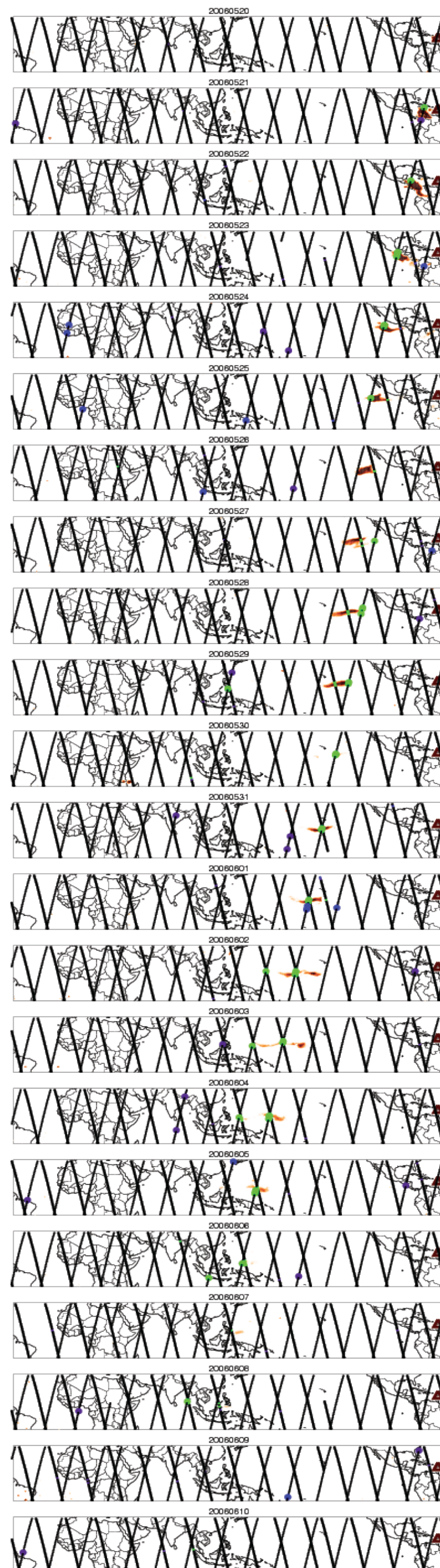


Figure 3. SO₂ plumes from the Soufrière Hills (16.72N, 62.18W) eruption on May 20th, 2006 observed by both OMI (red polygons) and MLS (colored circles (day/night)). Color indicates the height of peak value observed by MLS: purple: 215 hpa, blue: 146-100 hpa, green: 68 hpa, yellow: 46hpa. There are 135 kton SO₂ emitted by this eruption and the height of the initial plume is ~16.8km.

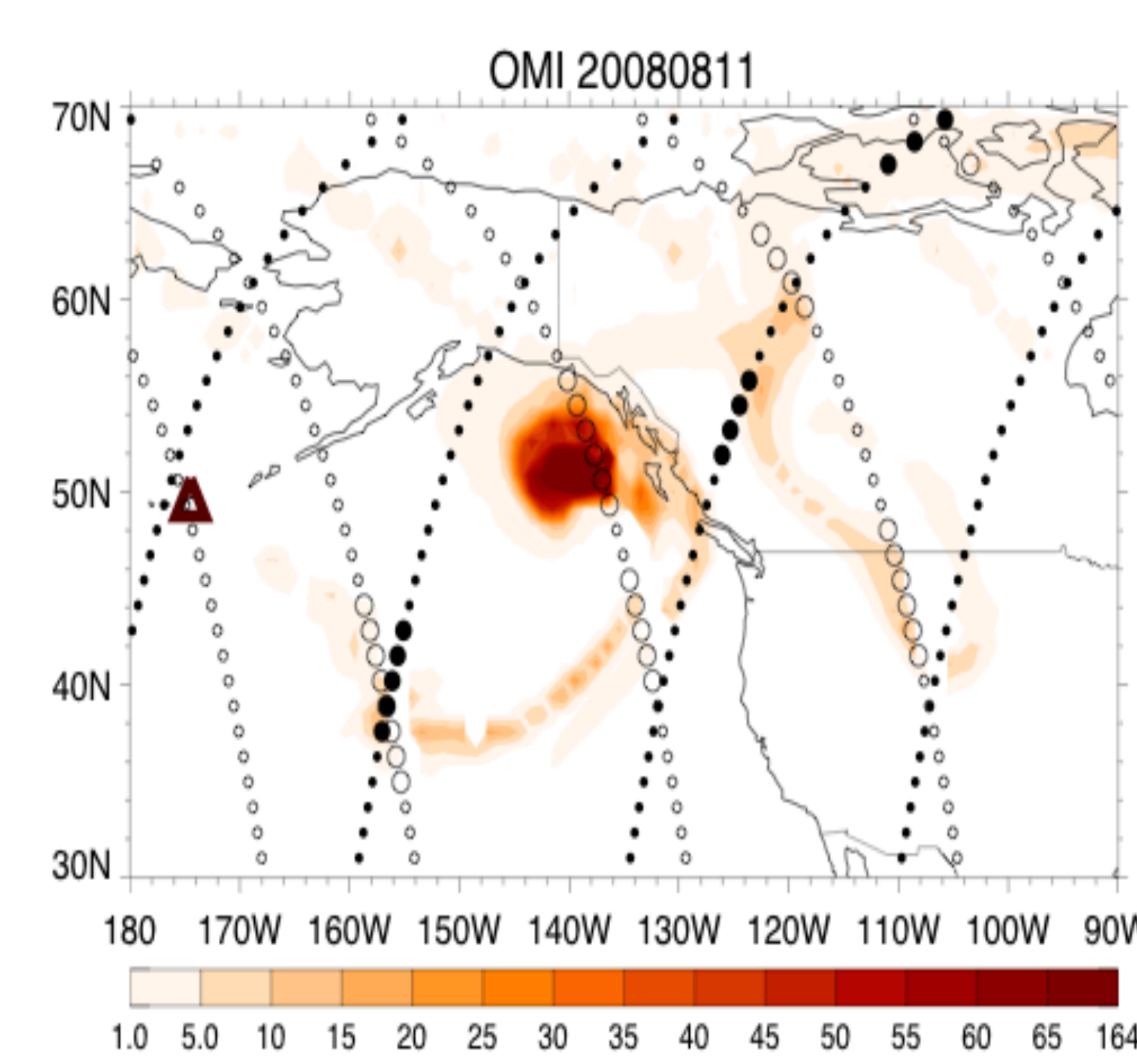


Figure 4. SO₂ plumes from the Kasatochi (52.18N, 175.51W) eruption on August 8th, 2008 as seen by both OMI and MLS. (Follow Read et al., 2009)

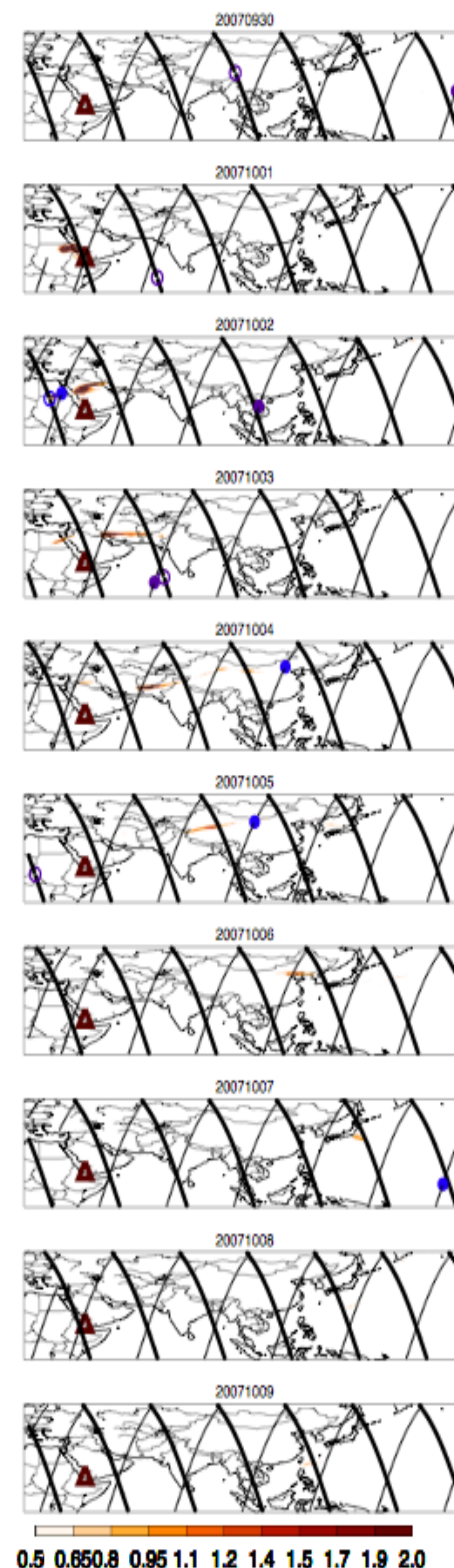


Figure 5. SO₂ plumes from the Tair, Jebel (15.55N, 41.83 E) eruption on September 30th, 2007. Plumes traveled eastward and circled around west Pacific ocean. Please notice the difference on the direction of plume movement as shown in Figure 3. These two plumes originated from same latitude, similar initial plume height, while different season and different magnitude (135 kton vs. 80 kton).

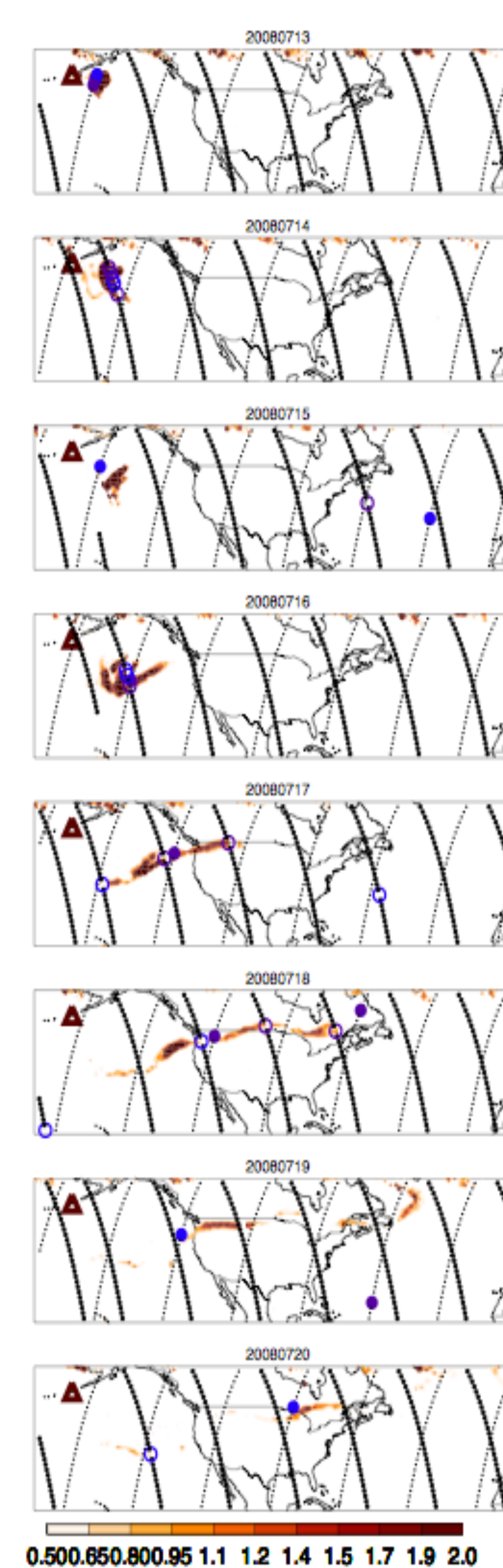


Figure 6. Okmok (53.43N, 168.13W) erupted on July 22nd and 23rd of 2008. Both OMI and MLS saw the plumes crossing N. America continent in several days.

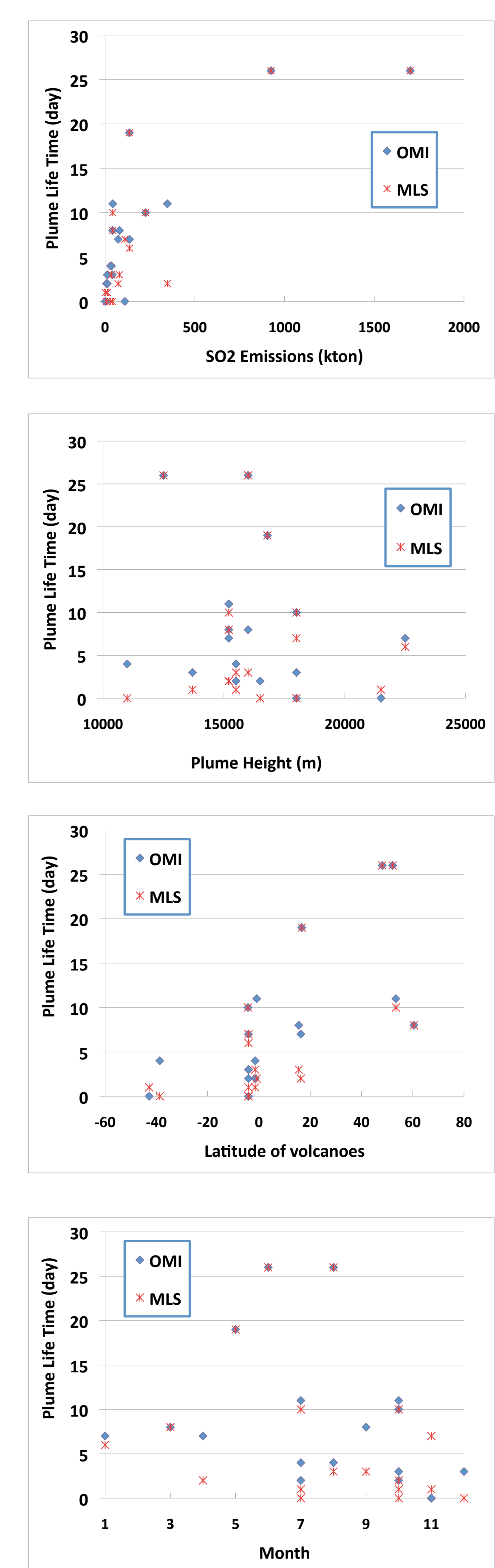
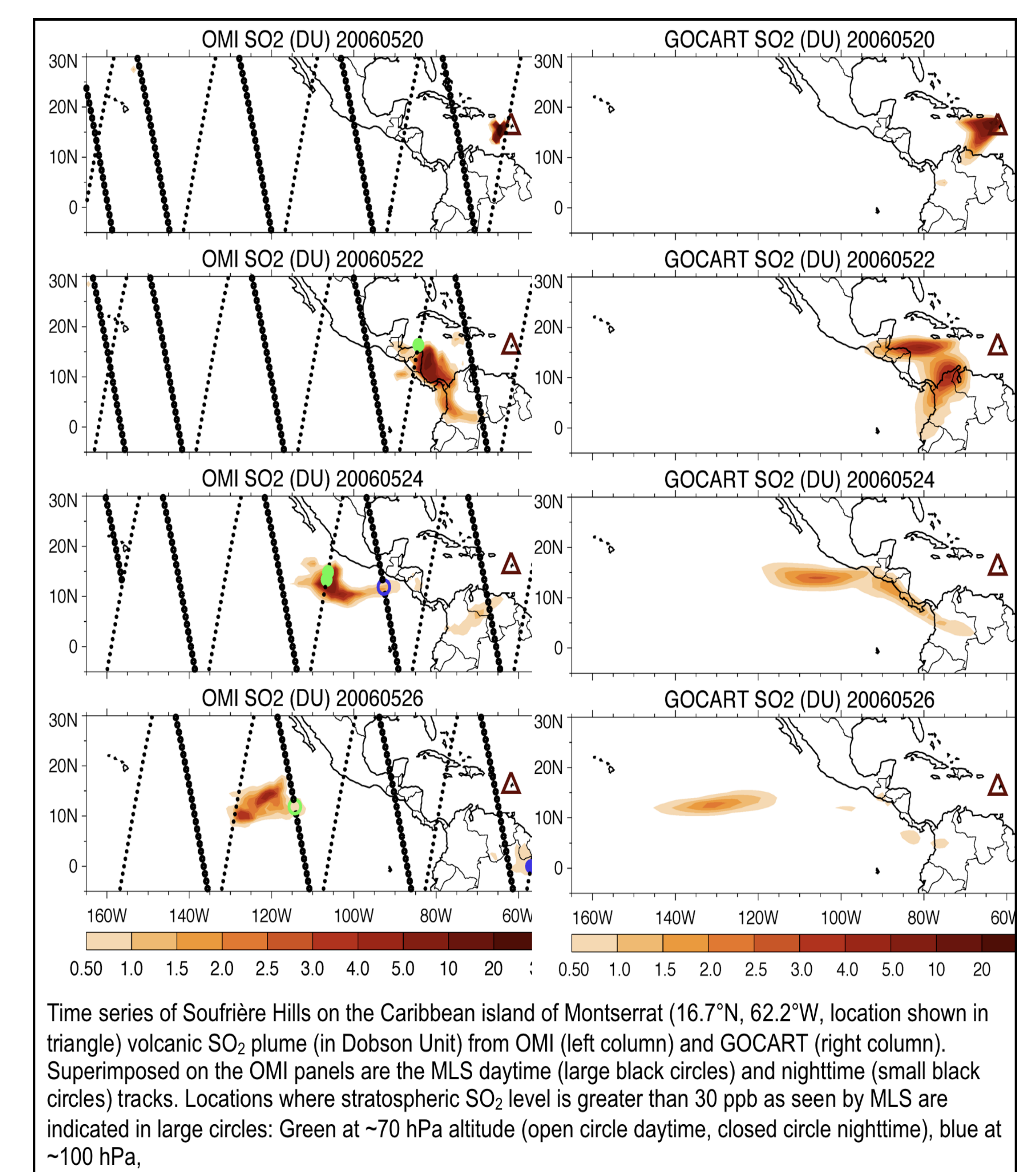


Figure 7. The lifetime of SO₂ plumes from large eruptions observed by both OMI and MLS as a function of total SO₂ emissions, initial plume height, volcano latitude and eruption season.



Time series of Soufrière Hills on the Caribbean island of Montserrat (16.7°N, 62.2°W, location shown in triangle) volcanic SO₂ plume (in Dobson Unit) from OMI (left column) and GOCART (right column). Superimposed on the OMI panels are the MLS daytime (large black circles) and nighttime (small black circles) tracks. Locations where stratospheric SO₂ level is greater than 30 ppb as seen by MLS are indicated in large circles: Green at ~70 hPa altitude (open circle daytime, closed circle nighttime), blue at ~100 hPa,